U.S. Navy (Julio Rivera)

MV-22 Osprey takes off from USS *Bataan* in Mediterranean

The V-22 Osprey

FROM TROUBLED PAST TO VIABLE AND FLEXIBLE OPTION

By ERIC BRAGANCA

After a few years of staying out of the limelight, the V-22 is back in the news because of a recent crash in Morocco that claimed the lives of two Marines and as the object of press and congressional inquiries for possible budget cuts.[1] After 10 years of expanding defense spending, military programs are again challenged to justify their funding and existence. American involvement in Iraq is over, Osama bin Laden is dead, and the President has vowed to begin withdrawing from Afghanistan soon. Does America still need the V-22? Yes. The American people deserve the best value for their dollar on any program during any time period despite any budget realities, and the V-22 has slowly and quietly become a solid, efficient performer. But there are still critics who do not know the quiet truths about the V-22.[2] It has an enviable safety record (despite the most recent crash), is cost-efficient, and has the flexibility to take on new roles and missions to handle our continued global security demands. No single aircraft is the answer to all of America's needs, but the V-22 offers the best troop-transport capability now and through the next decade.

Surprising Safety Record

Many who are familiar with the history of the V-22 recall the early years of its development when a series of high-profile crashes nearly caused the Department of Defense (DOD) to cancel the program. Richard Whittle, in *The Dream Machine*,[3] gives an excellent accounting of those days and the terrible impact they had on the people involved. The new tilt-rotor design and challenging military requirements demanded numerous compromises to save weight and increase speed as well as survivability in combat environments. A series of crashes and the tragic

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loss of lives as the program rushed to meet military timelines caused a redesign of critical components. The "new" V-22 began flying again in 2001 and has slowly become one of the safest combat aircraft in the Marine Corps inventory. The redesign of some key areas of the aircraft in 2000 and 2001 made a dramatic improvement in the safety of the aircraft. These improvements made an immediate, although unheralded, improvement in its safety. The V-22 went from near extinction to becoming one of the safest aircraft in the Marine vertical-lift inventory. The Marine Corps accident rate for all of its aircraft since 2001 (the last 10 years) is just under 2.5 mishaps for every 100,000 flight hours.

Before Morocco, the Osprey's crash rate was half that and slightly better than the venerable CH-46, which it is replacing in Marine squadrons. To have a new aircraft with a radically new design sustain a 10-year safety record better than other aircraft that are much better understood is exceptional. Even with the Morocco fatalities, the V-22 accounts for only 6 deaths out of the 600+ that have occurred in rotary-wing mishaps since 2001. Rotary-wing operations remain highly dangerous, and the V-22 is no exception. Ospreys have flown over 100,000 flight hours with over half of that coming in the last 3 years. During that time, V-22s have completed numerous deployments to Iraq, Africa, and Afghanistan, and also have performed exceptionally well in high-profile missions such as the rescue of an American pilot in Libya and supporting the bin Laden raid in Pakistan.

In the last few years, the V-22 experienced fires around the engines due to leaking hydraulic fluid dripping onto hot metal. Because the V-22 has an engine and rotor system that tilts during every takeoff and landing, there are larger and different stresses put on components in those areas than in other aircraft. In response to those problems, government and aircraft manufacturers implemented hardware and software changes to detect and prevent the leaks. Initially, the fixes just notified the crew that the hydraulic system was about to leak and shut down that part of the system. Follow-on improvements installed better hydraulic lines in key areas, which prevented the leaks. After a series of tests, engineers learned that a blower, driven by the hydraulics, was causing extreme pressure changes in the hydraulic system. This blower is soon to be replaced throughout the fleet even though the aircraft has not experienced an engine fire since the improved hydraulic lines have been installed. While the improved lines are good, the new blower will prevent the hydraulic pressure changes and is an even better solution. The crews and passengers who fly in the V-22 deserve this level of safety and protection, and they are now getting it. Furthermore, improving safety continues to be a part of the V-22 program.

Before the Marine crash, which is still under investigation, the Air Force lost a CV-22 in April 2010 during a combat mission in Afghanistan supporting special operations forces. This crash was terrible for the families who lost loved ones, but it did highlight how far the V-22 has come in openness and trust in the aircraft by the people who fly it and fly in it. Sadly, 4 people died, but 16 survived even though the aircraft broke apart during the catastrophic impact with the ground. The joint command responsible for the mission launched the CV-22 that night into a challenging weather environment in a remote mountainous target area against a hostile force. They were confident that the V-22 was capable and safe. Two Air Force safety boards reviewed the crash circumstances and found that the extreme environment—high altitude, darkness, and featureless terrain—was the most likely cause of the crash. While one of the boards suggested an engine failure might have contributed, the board lacked evidence. A joint government and industry technical investigation of one of the engines indicated no failure; the other engine was not recovered. A government review of the crash data (speed, altitude, fuel status) showed that an engine failure was highly unlikely and would not have caused the crash. Based on that technical review, Air Force Special Operations Command publicly discounted an engine failure as the cause.[4] The CV-22 returned to combat missions a few days after the crash and continued operating in the extreme Afghanistan environment without incident—the commanders, crews, and passengers did not lose faith in the aircraft. The V-22 community did not shy away from open and public scrutiny of the safety or usefulness of the aircraft.

Numerous other claims about the V-22 have proven untrue. Some claims seemed superficially credible until examined more closely. One completely false claim was that the V-22 would not be supportable on Navy ships such as the CH-46s it was replacing. However, Marines have deployed more than three squadrons on ships in the last 2 years, including a Marine air element on the USS *Kearsarge* that used its V-22s to rescue an F-15 pilot who ejected over Libya in March 2011. Another claim that falls into the "half-truth" category is that V-22s cannot autorotate (the method helicopters use to land when all engines fail[5]). It is true, but irrelevant, that the V-22 cannot autorotate. The whole truth is that the V-22 has a larger flight envelope where it can survive a dual-engine failure than the flight envelope of any comparable aircraft. If both engines fail while it is flying fast (called "airplane mode"), the V-22 can glide like any fixed-wing aircraft, obviating the need for autorotation. So the only risk is when both engines fail while the V-22 is in "helicopter mode" (with the prop-rotors/engines pointed upward). V-22s spend the vast majority of their time operating in airplane mode and use helicopter mode only when taking off and landing. Every aircraft ever made has some combination of low speeds and altitudes that should be avoided because a loss of engine power will not allow a safe landing. Even helicopters have speed-altitude combinations that do not allow a successful autorotation landing. Because of its power and speed, the V-22 spends less time in these "avoid" regions than helicopters, making the V-22 less likely to experience a crash from a dual-engine failure—meaning safer operations for crew and passengers.

the V-22 went from near extinction to becoming one of the safest aircraft in the Marine vertical-lift inventory

V-22s started with a questionable safety record as the manufacturers and military testers learned about the new, unique tiltrotor machine. But since the redesign of the aircraft, the 1990s record of crashes has been replaced by 10 years of exceptional safety and a continued focus on making the aircraft safer. Despite the poor reputation earned by those early years, the V-22 community developed and maintained an openness to accepting scrutiny even when the worst happened.

U.S. Air Force (Andy M. Kin)

Navy SEALs hoisted onto Air Force Special Operations CV-22 Osprey at Hurlburt Field

Affordable Transportation

Recent congressional inquiries have focused on the cost of the V-22.[6] This is not surprising given the current financial climate. When V-22 costs are evaluated against what the military would need as an alternative, it proves an effective and efficient aircraft for DOD and the Nation. To make a fair comparison, the V-22 must be examined using initial purchase costs for a comparable fleet of replacements, but also including operating and maintenance costs as well as personnel costs needed to support operations—what the military calls *life-cycle cost*.

Each new Marine MV-22 costs approximately $74 million. The Air Force's CV-22 variant costs more—approximately $84 million each—because it has added avionics such as a terrain-following radar and advanced defensive systems to protect it against radar and infrared missiles. This seems high compared to the $16 million price tag for each Army basic H-60M. But a more advanced H-60, with defensive equipment and networked global communications for tomorrow's combat operations, costs much more. And when a basic H-60 is modified for a combat role, the price grows dramatically. Egypt bought four such H-60s in 2008 for $44 million each,[7] and the Air Force's combat replacement program is buying 10 H-60s that are expected to cost $40 million each after modifications to make them combat effective.[8] That is almost half as much as a single V-22, but an H-60 can hold only 7 to 10 troops while a V-22 can hold 24; in combat, V-22s have carried as many as 35 troops when the seats were removed and the troops were secured using tie-downs on the floor. A Marine squadron on a ship would need more than two-and-a-half times as many H-60s to carry the same number of troops as a single V-22. A V-22 can also fly twice as fast, which means it can go twice as far in the same time. A squadron equipped with H-60s would need more than twice as many aircraft to go half as far. To extend the range of the H-60, the military would need air refueling support (such as C-130s) or additional ground refueling assets (tanker trucks/personnel and security). When factoring in these additional costs for the same warfighting capabilities, the V-22 life-cycle cost is cheaper than an H-60 or other comparable options. This comparison is why the military stuck with the V-22 even when it had its early problems.

The civilian transport world uses different measures of efficiency than the military does. The government focuses on the overall cost, while the for-profit world focuses on the comparative advantage of the available options. The airline industry measures the efficiency of an aircraft using a formula that takes into account the cost to fly a specified mission, the number of passengers it can carry, and the distance flown—cost per available seat-mile. Employing a similar formula using the maximum range of different aircraft, it is possible to compare the cost-efficiency of the different options.

The Marine Corps did this analysis and found that while the V-22 costs more to fly per hour than other options, it is more efficient because it can carry more passengers a greater distance. The CH-46 costs $4,600 per hour to operate, but carries half as many passengers as the V-22 and travels slower and not as far. The CH-46 costs $3.17 per passenger-mile. The CH-53E, the Marines' heavy-lift helicopter, can carry extremely heavy loads on its cargo hooks (sling-loaded below the aircraft) but carries the same number of passengers as the V-22 (like the V-22, the CH-53E can carry more troops when loaded without seats, but this analysis uses troops-in-seats for comparison since this is the officially approved measure). The CH-53E costs the same to operate hourly as the V-22 but travels slower and therefore not as far, so it costs $3.12 per passenger-mile. The Navy's newest H-60 version—the MH-60S—costs much less per hour (just over $2,500), but it can carry only seven passengers and also has a shorter range. The MH-60S costs $2.84 per passenger-mile. The V-22 costs almost $11,500 per hour and can carry 24 passengers at speeds over 250 knots—nearly twice that of fully-loaded helicopters. The V-22 costs $1.75 per passenger-mile.

These cost numbers do not include the V-22 program office's recent cost-reduction initiatives, which garnered DOD's 2011 David Packard Excellence in Acquisition Award for exemplary innovations and best practices in the defense acquisition process by decreasing the cost per flying hour over 15 percent.[9] In 2010, the Osprey flight-hour cost was reduced to $10,400 per hour and as low as $9,400 per hour for the first half of 2011. Using the 2011 rate, the Osprey cost-per-hour drops to $1.43—half of the H-46 and H-60 rates. And these rates do not include the costs of additional support assets that alternative solutions would require, such as additional air refueling, fuel trucks, personnel, and so forth. The H-53s can carry heavier external loads, so the Osprey cannot assume the Marines heavy-lift role for moving artillery, vehicles, or other large equipment. But in the passenger-moving role, the V-22 is far cheaper than the alternatives currently in the military inventory. If the military only needs to move small numbers of troops short distances, the H-60 is more efficient. But the Marines, Army, and special operations forces routinely need to move larger forces and prefer to base as far from the enemy as possible.

Recent criticisms have focused on the cost of the V-22 but have failed to account for

the expense of its rivals. The cost of each V-22 is higher than alternative aircraft, but this ignores the fact that DOD needs fewer V-22s to accomplish the same mission. The V-22 is cheaper than other options using both a life-cycle cost and a cost-per-available-seat-mile analysis. It is quantifiably safer and cheaper than alternative vertical-lift options, and it also provides the desired qualitative advantages for today's and tomorrow's military needs.

U.S. Air Force (Markus Maier)

Air Force CV-22 Ospreys take off from Kirtland Air Force Base

Future Operations

Combat operations are complete in Iraq and should be winding down in Afghanistan in the next year or two. Already the United States is focusing on other areas of the world both for counterterrorism and for the potential of larger operations against more developed threats. As America transitions to these tasks, the V-22 becomes an even greater asset. With its ability to operate from Navy ships, it improves the country's ability to defend shipping lanes, conduct small counterterrorism missions, and participate in larger operations against larger forces where greater connectivity and defensive capabilities are needed.

In 2008, Colonel Glenn Walter, USMC, wrote that the V-22 would enhance military operations by exploring all nine principles of war.[10] His analysis stands today and is reinforced by the last 4 years of V-22 combat operations. The Air Force Osprey variant can avoid detection to surprise an enemy with advanced detection systems such as integrated defense networks found in China, Iran, and North Korea. Since V-22s can be based farther away from their targets than alternative systems, troops will be safer from enemy attack—that is, ships launching V-22s can remain farther away from antiship missile launchers. The improved defensive systems of the CV-22 also provide greater security by protecting the troops from ground and air threats as they transit to and from targets. We have learned that access to bases is increasingly difficult and frequently requires political and military sacrifices to secure the basing rights necessary to conduct certain operations. As we face a future of more counterterrorist missions such as the one that killed bin Laden, the United States may not have readily available bases next door such as Afghanistan provided. Should the United States lack that advantage for future high-priority missions in areas such as the Pacific Rim or Africa, the V-22 becomes invaluable. The political advantage of decreased reliance on sometimes questionable allies is incalculable.

DOD is looking at aircraft for a number of missions that have traditionally been seen as needing helicopters. Each Service is looking for replacements to existing aircraft because current options have reached the end of their service-life or need greater capabilities. The V-22 offers a highly competitive option for each of these demands, but many within DOD have shied away from considering it because of misperceptions shaped by the colored history of the aircraft. With the safety and cost advantages easy to see, the V-22 should move to the front of the line for all the Services in some key areas.

The Air Force has been looking for a combat search and rescue (CSAR) replacement to its HH-60. The Service has a small fleet of highly modified H-60s with aerial refueling probes, internal fuel tanks, advanced navigation systems, improved defensive systems, rescue hoists, and long-range communication capabilities. As already described, the V-22 is superior to the H-60 in all these areas. And since the Air Force has already paid for the development and test costs of these upgrades on the V-22, it could start buying combat-ready aircraft rapidly (although that is not an easy prospect in the current fiscal environment). The increased speed of the V-22 also improves the CSAR force's chance of arriving within the *golden hour*—that first hour when the opportunity to save a life is greatest. A CSAR V-22 has more cabin room than an H-60 so a medical team could perform lifesaving actions with more medical equipment while the aircrew moves the patient directly from the battlefield to the trauma center faster and without the need for a transfer to a longer-range aircraft. The V-22 is tailor-made for this lifesaving combat mission.

The Navy is looking for a replacement for its small fixed-wing aircraft carrier resupply aircraft, the C-2. The V-22 can do this mission as well. Although not a complete replacement for the C-2, the V-22 can add new mission areas that the C-2 cannot do, such as resupplying noncarriers ships (with helicopter pads) and long-range overwater rescue. Despite having only a handful of aircraft, the C-2 achieved a logistics advantage because it shared many common parts with the Navy's early warning and command aircraft, the E-2. This meant that the C-2 shared space for people and parts aboard an aircraft carrier and achieved some economies of scale with logistics and training. Because the Marine Corps and Air Force are already using V-22s, these economies of scale will exist if V-22s take over this mission area, too. V-22s have established worldwide logistics chains ashore and afloat. The Marines operate a jointly manned training center in North Carolina training Marine and Air Force aircrew and maintainers. The loss of commonality with the E-2 will be balanced by commonality with a larger fleet of Marine and Air Force V-22s.

The Army is beginning to focus on developing a new, faster helicopter.[11] According to Major General Anthony Crutchfield, director of the U.S. Army Aviation Center of

Excellence, the Army wants an aircraft that "flies faster, longer, carries more payload, requires a smaller logistical footprint and is more survivable."[12] The current development has focused on an aircraft much like the cancelled RAH-66 Comanche, a helicopter-type aircraft with a small rear-facing propeller that pushes the aircraft to faster speeds than current helicopters. One prototype is already flying, but it has no troop-carrying capability. And while this development offers new opportunities and capabilities, it is not slated to be ready until 2030, leaving the Army with a 20-year capability gap. In the interim, the Army could use the V-22 to expand the mission set of faster vertical-lift aircraft by integrating more weapons and electronic systems to meet its needs while it continues to develop its next-generation helicopter. For example, the Army could immediately begin using V-22s for its medical evacuation mission. In a role that is similar to the Air Force's CSAR mission, the advantages are compelling. Once introduced to the aviation inventory, the Army could then expand the V-22 role into other areas planned for future developmental aircraft. This would allow the Army to conduct risk-reduction development and evaluation of Army-unique equipment, which will decrease the time to integrate them on new aircraft. This will mitigate the problems experienced with the Littoral Combat Ship (where the Navy has experienced delays fielding the ship, which has further delayed the planned subsystems). Since a next-generation helicopter requires years of development and testing before beginning to develop the advanced avionics, using V-22s now can accelerate some of those capabilities while decreasing the follow-on integration time for the next aircraft.

The V-22 offers the military many options for many different missions. When it was first developed, some saw it as the future of all aviation, both military and commercial. That utopian vision has not come to pass, but the V-22 does offer some concrete advantages right now for each of the Services' pressing aviation needs. In these fiscally challenged times, the V-22 offers safe capabilities at reasonable costs without having to wait years for new development.

Conclusion

The V-22 has a troubled past that includes crashes, development problems, and high costs. But the improvements incorporated into the modern V-22 have resulted in an unparalleled and enviable safety record for a combat aircraft. The V-22 community has continued to strive for safer airplanes and has demonstrated a level of openness that is refreshing and indicates confidence in its usefulness. After years of criticism for being expensive, the V-22 is showing that it is cheaper to buy and operate than other vertical lift aircraft for the long-range troop-carrying role. It rapidly became a high-demand asset in Iraq and Afghanistan. However, the V-22's advantages go far beyond our current conflicts. It can succeed in missions around the world from discrete counterterrorist raids to small-scale conflicts to major fights against technologically advanced nations. It offers benefits to all of these missions with enhancements to the military principles of mass, maneuver, surprise, security, and simplicity. As DOD and Congress look to manage a burgeoning budget while maintaining the world's best military force, the V-22 should rise to the top of the list of systems needed for today and tomorrow.

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Tilt-rotor aircraft are not ready to transform aviation, as some have claimed. But this first-generation V-22 is ready for more missions while helping to keep the military budget from bankrupting the country. It proves itself every day for the Marines and special operations troops who have come to rely on it and are developing new ways to integrate it into their daily missions. It can be adapted and produced for even more military uses without the need for the lengthy development and testing of basic aircraft that delay all new programs and cost billions of dollars. All new types of aircraft have experienced development problems as the builders and users tried to learn how to fly and use them. Early fixed-wing aircraft took years to develop into useful machines, as did jets, spacecraft, and helicopters. The V-22, with its radical tilt-rotor concept, was no exception. More lessons can be learned, but with over 100,000 flight hours (half of those in the last 2 years), the V-22 has become safer, cheaper, and more capable than other options for America's troop-carrying role. **JFQ**

NOTES

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